The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.1 Recognize that matter is composed of extremely small particles called atoms.
Taxonomy level: 1.1-B Remember Conceptual Knowledge

Previous/Future knowledge: In 5th grade (5-4.1), students recalled that matter is made up of particles too small to be seen. Students have not been introduced to the concept of atoms in previous grades. Students will further develop the concept of atoms and atomic structure in high school Physical Science (PS-2.1 and PS-2.2).

It is essential for students to know that matter is composed of extremely small particles, too small to be seen with a classroom microscope, called *atoms*.

- Atoms are the smallest part of an element that has the chemical properties of the element.
- A single atom has mass and takes up space.

It is not essential for students to know the subatomic particles, for example, protons, neutrons, and electrons, which compose atoms. Atomic models do not need to be constructed or drawn.

Assessment Guidelines:
The objective of this indicator is to *recognize* that matter is composed of extremely small particles called atoms; therefore, the primary focus of assessment should be to remember the information that atoms are the extremely small particles of matter. However, appropriate assessments should also require students to *recall* that atoms have properties of matter.

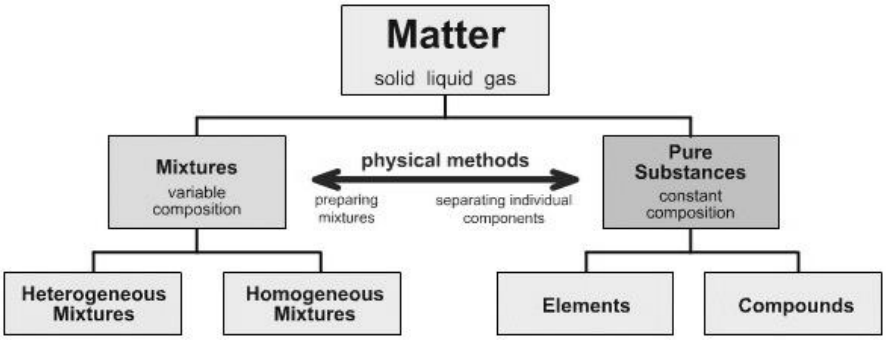
The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.2 Classify matter as element, compound, or mixture on the basis of its composition.
Taxonomy level: 2.3-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of mixtures in 5th grade (5-4.3). In 5th grade (5-4.4), students separated mixtures using the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation. Students have not been introduced to the concept of elements or compounds in previous grades. Students will further develop the concepts of elements, compounds, and mixtures in high school Physical Science (PS-3.4).

It is essential for students to know that matter can be classified on the basis of its composition:



Elements
- Elements are pure substances that cannot be changed into simpler substances.
- Elements are composed of one kind of atom.

Compounds
- Compounds are pure substances that are composed of two or more types of elements that are chemically combined.
- Compounds can only be changed into simpler substances called elements by chemical changes (7-5.10).
- One way that two or more atoms can combine is to form a *molecule*.

Mixtures
- Mixtures are composed of two or more different substances that retain their own individual properties and are combined physically (mixed together).
- Mixtures can be separated by physical means (filtration, sifting, or evaporation).
- Mixtures may be heterogeneous or homogeneous.
  - In a *heterogeneous mixture*, which is not uniform throughout, the component substances can be visibly distinguished.
  - In a *homogeneous mixture*, which is uniform throughout, the substances are evenly mixed and cannot be visibly distinguished. The particles of the substances are so small that they cannot be easily seen. Another name for a homogeneous mixture is a solution.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

It is not essential for students to know that molecules are the smallest part of covalent compounds. It is not essential for students to understand isotopes. Students do not need to physically separate mixtures as this was done in 5^{th} grade.

Assessment Guidelines:
The objective of this indicator is to *classify* matter as element, compound, or mixture on the basis of its composition; therefore, the primary focus of assessment should be to categorize matter depending on its composition. However, appropriate assessments should require students to *recognize* the classifications of matter based on composition; *exemplify* matter based on its composition; *illustrate* with words, pictures, or diagrams categories of matter; *infer* the types of matter based on characteristics; *compare* the types of matter based on their characteristics; or *summarize* the properties of the three types of matter.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.3. Compare the physical properties of metals and nonmetals.
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 5th grade (5-4.2), students compared physical properties of states of matter. Students have not been introduced the concept metals and nonmetals in previous grade levels. Students will further develop the concepts of metals and nonmetals in high school Physical Science (PS-2.3)

It is essential for students to know that metals and nonmetals are two major groups of elements that have different physical properties.

Physical properties of metals include:
- *Luster*—Having a shiny surface or reflecting light brightly
- *Conductors*—Heat and electricity move through them easily
- *Malleable*—Ability to be hammered into different shapes
- *Ductile*—Ability to be drawn into a wire
- *High density*—Heavy for their size

Physical properties of nonmetals include:
- *Dull*—Not shiny
- *Nonconductors*—Heat and electricity do not move through them easily
- *Brittle*—Break or shatter easily (solids)

It is not essential for students to know the chemical properties of metals versus nonmetals, or the electron arrangement in atoms of metals versus nonmetals.

Assessment Guidelines:
The objective of this indicator is to *compare* the physical properties of metals and nonmetals; therefore, the primary focus of assessment should be to determine the differences between metals or nonmetals based on their physical properties. However, appropriate assessments should also require students to *infer* from a list of physical properties whether an object is metal or nonmetal; *recall* physical properties of metals and nonmetals; or *summarize* physical properties of metals and nonmetals.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.4 Use the periodic table to identify the basic organization of elements and groups of elements (including metals, nonmetals, and families).
Taxonomy level: 3.2-B Apply Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the periodic table in previous grade levels. Students will further develop the concept of the periodic table in high school Physical Science (PS-2.3).

It is essential for students to know how to use the periodic table to identify the basic organization of elements.

- A horizontal row on the periodic table is called a *period*.
- Every periodic table will have a square for each element with the atomic number, atomic mass, element name, and the element symbol.
- The elements on the periodic table are arranged numerically by atomic numbers.
- *Families*, also called groups, are vertical columns of elements on the periodic table; they are usually numbered 1-18. Elements in the same family have similar properties.

On the *periodic table* there is a zigzag line on the right side of the table. There are two sections of elements on the periodic table, metals and nonmetals.

Metals

- A major classification of elements generally located on the left side of the zigzag line on the periodic table.
- Examples of metals are: Sodium (Na), Calcium (Ca), Iron (Fe), and Aluminum (Al). The majority of elements are metals.

Nonmetals

- A major classification of elements generally located on the right side of the zigzag line on the periodic table.
- Examples of nonmetals are: Chlorine (Cl), Oxygen (O), Sulfur (S), and Iodine (I).

It is not essential for students to know how each element gets its atomic number (no subatomic particles are part of this standard). They do not need to know the names of the individual families of elements or to identify metalloids.

Assessment Guidelines:
The objective of this indicator is to *use* the periodic table to identify basic organization of elements on the periodic table, the metal and nonmetal divisions, and to locate families of elements; therefore, the primary focus of assessment should be to recognize the organization of the elements by using the periodic table. However, appropriate assessments should also require students to *exemplify* elements that are metals and nonmetals given a periodic table; *recognize* the location of an element on the periodic table; *recognize* the location of groups of metals and nonmetals; *recognize* that families are columns of elements; or *identify* an element using the organization of the periodic table *(atomic number or symbol).*

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.5 Translate chemical symbols and the chemical formulas of common substances to show the component parts of the substances (including NaCl [salt], H_2O [water], $C_6H_{12}O_6$ [simple sugar], O_2 [oxygen gas], CO_2 [carbon dioxide], and N_2 [nitrogen gas]).

Taxonomy level: 2.1-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concepts of chemical symbols and the chemical formulas in previous grades. Students will further develop the concepts of chemical symbols and chemical formulas in high school Physical Science (PS-4.5).

It is essential for students to know that *chemical symbols* show the atoms of the elements composing a substance. Symbols are written with one, two, or three letters. The first letter is always capitalized. Each element has a different symbol.

NOTE TO TEACHER: Students should know the symbols and names for the following common elements:

Element	Symbol
Sodium	Na
Chlorine	Cl
Hydrogen	H
Oxygen	O
Carbon	C
Nitrogen	N

- Elements are made up of one kind of atom and the symbol for each element is unique.
- Compounds are composed of more than one element and their formulas have more than one type of symbol showing the different elements that compose the compound.

Chemical formulas are constructed from the symbols of the elements composing the substances.

- In a chemical formula, the numbers as *subscripts* show how many of each kind of atom are in the compound.
- The subscript is written to the lower right of the element symbol.
- If no subscript is written, only one atom of that element is part of the compound. For example, in H_2O, the number 2 is the subscript for hydrogen and means that there are 2 atoms of hydrogen in the compound of water; since there is no subscript for oxygen it is assumed to be one atom of oxygen.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

NOTE TO TEACHER: Students should be able to recognize the common names of the substances listed in the indicator (table salt, water, simple sugar, oxygen gas, carbon dioxide, and nitrogen gas) and the names and symbols for the elements listed in the chart (above). For example, when students see the formula H_2O, they should be able to recognize that this is water.

It is not essential for students to memorize the symbols for the elements (other than those listed in the chart above) or interpret the chemical formulas for substances not listed in 7-5.5. Students do not need to know how to assign subscripts to elements or compounds.

Assessment Guidelines:
The objective of this indicator is to *translate* chemical symbols and chemical formulas of common substances listed above to show the component parts; therefore, the primary focus of assessment should be to interpret a chemical symbol and formula to identify the element(s) and the number of atoms of that element in a formula of the substance. However, appropriate assessments should also require students to *recognize* the chemical symbols and formulas of common substances; or *recall* the components.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.6 Distinguish between acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.
Taxonomy level: 4.1-B Analyze Conceptual Knowledge

Previous/Future knowledge: In 5th grade (5-4.5), students explained how the solute and the solvent in a solution determine the concentration. Students have not been introduced to the concept of solutions of acids and bases nor their concentrations in previous grades. They will further develop these concepts of acids and bases in high school Physical Science (PS-3.8).

It is essential for students to know that substances can be classified as acids, bases or neutral based on their pH. Acids and bases are solutions usually with water as the solvent.

pH

- The *pH scale* is a way to measure how acidic or basic a solution is.
- The pH range of a solution is between 0 and 14.
- The pH of pure water is 7. Any solution with a pH of 7 is *neutral solution*. It is not an acid or a base.
- The pH of an acidic solution is less than 7; the lower the number, the more acidic the solution.
- The pH of a basic solution is greater than 7; the higher the number, the more basic the solution.

Acid

- Acids can be identified by their sour taste (for example lemons and oranges contain acids); by their reaction with some metals such as zinc, and by their reaction with bases to form a neutral pH solution (for example, vinegar reacting with limestone).

Base

- *Bases* can be identified by their bitter taste (for example, unsweetened cocoa has a bitter taste); by its slippery feel (for example, dish detergent) and by its reaction with acids to form a neutral pH solution (for example, an antacid to soothe an acid stomach).

Neutral Solution

- It is neither an acid nor a base.
- For example, pure water is a neutral solution and has a pH of 7.

NOTE TO TEACHER: Students should not use a taste test on laboratory chemicals. Touching an unknown substance to observe if it feels slippery should not be done on laboratory chemicals as some strong bases burn the skin when touched.

It is essential for students to know how to use indicators (including litmus paper, phenolphthalein, and pH paper) to determine the relative pH of a solution. *Indicators* are substances that can be used to determine whether a solution is acidic, basic, or neutral.

Litmus paper
- Has a special dye on it that changes colors in the presence of an acid or base.
- Blue litmus paper turns red in an acid, and stays blue in a base.
- Red litmus paper turns blue in a base, and stays red in an acid.
- Both red and blue litmus paper turn violet in a solution that is neutral (neither an acid nor a base).

NOTE TO TEACHER: Students need to know the indicator colors for litmus paper.

Phenolphthalein
- Is used to test for the presence of a base.
- It is a colorless chemical that turns magenta (bright pink) in a base, and stays colorless in neutral or acidic solutions.

NOTE TO TEACHER: Students need to know the indicator colors (magenta for base or colorless) for phenolphthalein.

pH paper
- Has a range of colors depending on the pH of the solution.
- The color of the paper is compared to the chart on the vial to determine the pH.

It is not essential for students to know the specific colors of pH paper at given pH ranges as indicated on the chart on the vial; how to perform a neutralization of a solution to form water and salt; or how to use other indicators to determine the pH of a solution (such as purple/red cabbage juice and pH meters).

Assessment Guidelines:
One objective of this indicator is to *distinguish* between acids and bases; therefore, the primary focus of assessment should be to analyze properties of solutions to determine whether they are acids or bases. However, appropriate assessments should also require students to *identify* a solution as acidic or basic given its properties; *recall* the pH range associated with acidic, basic, and neutral solutions; *exemplify* substances that are acids or bases; *classify* a substance as an acid or base given its pH or description; or *summarize* the differences between acids and bases.

Another objective of this indicator is to *use* pH indicators to determine relative pH; therefore, the primary focus of assessment should be to apply a procedure that uses pH indicators to determine the relative acidic or basic properties of different solutions. However, appropriate assessments should also require students to *infer* the pH of a solution given the results of a particular indicator; *compare* solutions to determine which is more acidic, more basic, or neutral depending on the pH results; or *summarize* the use of indicators in determining the pH of a solution.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.7 Identify the reactants and products in chemical equations.
Taxonomy level: 1.1-B Remember Conceptual Knowledge

Previous/Future knowledge: In 5th grade (5-4.7), students illustrated the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot easily separated. Students have not been introduced to the concept of reactants or products or chemical equations in previous grades. Students will further develop the concept of chemical reactions and equations in high school Physical Science (PS-4.6 and PS-4.7).

It is essential for students to know that when a substance is broken apart or when substances are combined and at least one new substance is formed, a *chemical reaction* has occurred.

Chemical equation
- Used to represent a chemical reaction that has occurred.
- It contains the chemical names or the chemical formulas of the substances that are involved in the reaction.
- An arrow is used to distinguish between the substances that are broken apart or combined from the substances that are formed in the reaction.
- The arrow can be translated as "yields" or "makes."

Reactant
- Substances broken apart or combined in a chemical reaction.
- Reactants are located on the left side of the arrow.

Product
- New substances formed in a chemical reaction.
- Products are located on the right side of the arrow.

For example, the following chemical equation shows the formation of water (H_2O) from oxygen gas (O_2) and hydrogen gas (H_2). The reactants are oxygen gas (O_2) and hydrogen gas ($2H_2$), located on the left side of the arrow. The product, water ($2H_2O$), is on the right side of the arrow.

Reactant		**Product**
Hydrogen gas + Oxygen gas	Yields/Makes	Water
$2H_2 + O_2$	→	$2H_2O$

NOTE TO TEACHER: Coefficients in chemical reactions are addressed in indicator 7-5.8.

It is not essential for students to name the various types of chemical reactions that occur (single displacement, double displacement, decomposition, or synthesis) or determine the products in a chemical reaction given the reactants.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *identify* reactants and products in chemical equations; therefore, the primary focus of assessment should be to retrieve from memory information about the location of reactants and products in a chemical equation. However, appropriate assessments should also require students to *recall* the characteristics of reactants and products in a chemical reaction; *or recognize* the component parts of a chemical equation.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.8 Explain how a balanced chemical equation supports the law of conservation of matter.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 6th grade (6-5.2), students explained how energy can be transformed from one form to another in accordance with the law of conservation of energy. Students have not been introduced to the concept of the law of conservation of matter in previous grades. Students will further develop this concept of balanced chemical equations and conservation of mass in high school Physical Science (PS-4.7).

It is essential for students to know that the amount of matter does not change during a chemical reaction, only that the atoms are rearranged to form new substances.

- The *law of conservation of matter* states that matter can neither be created nor destroyed, but can be changed in form.
- Because matter is neither created nor destroyed, the total mass of the material(s) before the reaction is the same as the total mass of material(s) after the reaction.
- A *balanced chemical equation* has the same number of each kind of atom on the reactant side as on the product side.
- To determine whether a chemical equation is balanced, two numbers are considered: the subscript (7-5.7) and the coefficient.
- A *coefficient* is the number that comes before the chemical formula and indicates the number of particles that participate in the reaction.
- In order to determine whether an equation is balanced, multiply the number in front of the chemical formula in the equation (coefficient) by the number written below the symbol for the element(s) (subscript) in the formula. If no coefficient is written, it is understood to be one. For instance, for "$2H_2O$" there are 4 hydrogen atoms and 2 oxygen atoms.
- The number of each kind of atom on the left side of the arrow must equal the number of each kind of atom on the right side of the arrow for the equation to be balanced.

For example, in the chemical equation for the reaction of water (liquid) breaking into hydrogen (gas) and oxygen (gas) as represented by the balanced chemical equation:

$$2H_2O \rightarrow 2H_2 + O_2$$

- There are four hydrogen atoms on the reactant side (coefficient of 2 x subscript 2) and four hydrogen atoms on the product side (coefficient 2 x subscript 2).
- There are two oxygen atoms on the reactant side (coefficient 2 x (understood) subscript 1) and two oxygen atoms on the product side ((understood coefficient 1 x subscript 2).
- There are the same number of hydrogen atoms (4) and oxygen atoms (2) on both sides of the equation; therefore, the equation is said to be balanced.
- Since there are the same number of each kind of atom on both sides of the arrow and atoms represent kinds of matter, the amount of matter is the same on both sides of the equation, which supports the law of conservation of matter.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

It is not essential for students to know how to determine coefficients to balance chemical equations. They must only recognize that an equation is balanced. They do not have to know how to create the chemical formulas for substances. They must only analyze given formulas for common substances to determine the number of each component part. Substances with polyatomic ions (for example, $(NH_4)_2CO_3$ ammonium carbonate) as part of their chemical formula are not the intent of this indicator.

Assessment Guidelines:

The objective of this indicator is to *explain* how a balanced equation supports the law of conservation of matter; therefore the primary focus of assessment should be to construct a cause-and-effect model of how the number of atoms of elements on reactant side of the equation must equal the number of atoms of elements on the product side of the equation. However, appropriate assessments should also require students to *recall* the law of conservation of matter; *recognize* whether or not a chemical equation is balanced or not; *identify* the coefficient in a chemical equation; or *summarize* how the law of conservation of matter relates to a balanced equation.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.9 Compare physical properties of matter (including melting or boiling point, density, and color) to the chemical property of reactivity with a certain substance (including the ability to burn or to rust).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of properties of matter in 2nd grade (2-4.1), in 3rd grade (3-4.1), and physical properties of the states of matter in 5th grade (5-4.2). Students were introduced to the concept of physical properties but not the chemical properties of matter in previous grades. Students will further develop the concept of physical and chemical properties in high school Physical Science (PS-3.1).

It is essential for students to know that physical and chemical properties can be used to identify substances.

Physical properties can be observed and measured without changing the kind of matter being studied. The following physical properties can be used to help identify a substance:

Melting Point
- The temperature at which a solid can change to a liquid.
- The temperature at which a pure substance melts is unchanging under constant conditions.
- Therefore, the melting point of a pure substance can be used as a physical property for identification. Ice melts to form liquid water at 0^0C (32^oF).

Boiling Point
- The temperature at which a liquid boils.
- During the process of boiling a substance changes from a liquid to a gas.
- Boiling begins when the liquid starts to form bubbles throughout, which grow larger, rise to the surface, and burst.
- As long as the substance is boiling the temperature of the liquid remains constant (at the boiling point).
- Boiling point is unchanging under constant conditions for a given substance and therefore can be used as a physical property for identification of the substance.
- The boiling point for pure water at sea level is 100^oC or 212^oF.

Density
- Density is a property that describes the relationship between the mass of a material and its volume.
- Substances that are denser contain more matter in a given volume.
- The density of a substance will stay the same no matter how large or small the sample of the substance, and therefore, density can be used as a physical property for identification of the substance.
- For example, lead is a very heavy, dense metal. The density of lead is much greater than the density of the very light metal, aluminum.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

NOTE TO TEACHER: Students do not need to calculate density given the mass and volume of a substance.

Color

- Color can be used to help identify a substance, along with other properties.
- By itself color is not a significant identifier of a substance.
- Absence of color is also a physical property.

Chemical properties can also be used to help identify a substance. Chemical properties can be recognized only when substances react or do not react chemically with one another, that is, when they undergo a change in composition. A chemical property of one substance usually involves its ability to react (combine) or not react with another specific substance. Two examples of chemical properties include:

The ability to burn

- The ability of a substance to burn is a chemical property that involves a substance reacting quickly with oxygen to produce light and heat.
- The process is called *burning*.

The ability to rust

- The ability of a substance to rust is a chemical property that involves a substance reacting slowly with oxygen.
- The process is called *rusting*.

It is not essential for students to calculate the density of a substance if given its mass and volume.

Assessment Guidelines:

The objective of this indicator is to *compare* physical properties to chemical properties of matter; therefore, the primary focus of assessment should be to determine the similarities and differences between physical and chemical properties of matter. However, appropriate assessments should also require students to *classify* properties as being physical or chemical; *exemplify* physical and chemical properties used to identify substances; or *summarize* the ways that physical properties and chemical properties are used to identify matter.

The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.10 Compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concepts of physical or chemical changes before this grade level. They will further develop the concept of physical and chemical changes in high school Physical Science (PS-4.6).

It is essential for students to know that physical and chemical changes affect substances in different ways.

Physical changes do not change the composition of a substance, only the physical properties. Evidences of a physical change include:

Change in state of matter

- When a substance changes from one state of matter to another (for example, changing from solid to liquid, from liquid to solid, or from liquid to gas), the composition of the substance remains the same.
- Examples of change in state might include: melting of ice cream, hardening of melted wax, or evaporating of water from wet clothes.
- When a substance changes directly from a gas to a solid (the forming of frost from water vapor) or from a solid to a gas (dry ice, solid air fresheners) that change of state is called *sublimation*. This is still a physical change because the composition of the substance remains the same.

Change in size or shape

- When a substance changes in size or shape (for example, cutting, tearing, dissolving, stretching, or wrinkling), its composition remains the same.
- Examples of change in size or shape might include: shredding paper, dissolving sugar in water, stretching a rubber band, wadding up a piece of paper, or denting a piece of metal.

Chemical changes result in the formation of one or more new substances with new chemical and physical properties. Evidences that a chemical change may have occurred include:

Color change

- When a substance changes color, the chemical composition of the substance may have changed (for example, iron turns to a reddish-brown when it rusts, clothes change color when bleach is added, apples turn brown when they react with oxygen in the air, or marshmallows turn black when burned).
- It is possible to have a color change without a chemical change (for example, adding food coloring to water).

Temperature change

- When a substance is combined with another substance, there may be an increase or decrease in temperature (for example, when wood burns to ash and gases, the temperature increases.
- It is possible to have a temperature change without a chemical change (for example, warming of the water in a pond).

Formation of a precipitate

- When two solutions are combined, they may form a solid substance. This solid substance is called a *precipitate* and indicates that a chemical change has occurred.
- For example when carbon dioxide is combined with aqueous calcium hydroxide (limewater), solid calcium carbonate (chalk) is formed as the precipitate.
- The precipitate may be in the form of very small particles, appearing as cloudiness in the solution or as a solid which settles to the bottom of the container.

Formation of a gas

- When solid or liquid substances are combined, they may form gas bubbles.
- The formation of the gas may indicate that a chemical reaction has taken place. For example when vinegar is added to baking soda, it forms carbon dioxide bubbles.
- It is possible to form gas without a chemical change (for example, when water is heated to boiling).

It is not essential for students to identify a reaction as exothermic or endothermic.

Assessment Guidelines:
The objective of this indicator is to *compare* physical changes to chemical changes; therefore, the primary focus of assessment should be to determine how physical and chemical changes are alike and different. However, appropriate assessments should also require students to *identify* a given change as physical or chemical; *exemplify* physical and chemical changes; *infer* whether a physical or chemical change has occurred based on the conditions given; *classify* changes as chemical or physical based on descriptions given; or *summarize* the evidences for a chemical change.